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TEXTILE RESEARCH

EDITORIAL

Two Industrial Revolutions

IN the throes of a second Industrial Revolution we are prone to forget that most of our experiences and complaints are very similar to those suffered and vocalized during the first Industrial Revolution.

Industrial Revolution No. 1 marked the transition from hand to machine production by empirical methods.

It overlapped the period covered by the Napoleonic wars and the latter's wastage of men and money.

To supply war's needs and to wipe out war's wastage production was stimulated many fold.

Productive capacity of the machine industries was expanded far beyond maximum consuming capacity of available markets.

Social theorists envisioned the approach of that altruistic period when a minimum of toil would provide man with ample leisure.

But men of the handicrafts sought to destroy the revolutionary machines, and manufacturers, in a blind struggle for self-preservation, forced an expanded production upon an already glutted market.

Slump succeeded slump; the industrial and financial future of the world seemed hopeless. But eventually, and without the aid of any man-made plan, demand balanced and occasionally exceeded supply, and emancipation from healthful labor awaited another industrial revolution.

Industrial Revolution No. 2 marks the transition from non-automatic to automatic machinery by scientific methods.

It has been accompanied and affected by all of the factors that played an important part during Industrial Revolution No. 1, but with all of them intensified to a twentieth-century acuteness.

Again a great war stimulated available productive capacity to a degree never before known. The glutting of markets, and so-called technological unemployment have been on a comparative scale.

Again manufacturers have engaged blindly in a struggle for the survival of the strongest, by forcing production upon an already glutted market.

Again social theorists have hailed the end of man's long struggle for leisure and a minimum of toil.

Again the future seems hopeless to those of little vision and faith. But as certainly as day follows night will we muddle out of the present industrial and economic darkness into the light.

To hasten the muddling we should analyze the basic differences between the second and first Industrial Revolutions, and then endeavor to plan future procedure intelligently, and follow it through systematically—and cooperatively if possible.

Two important factors that must emerge from this analysis are the great progress made during the last few decades in basic scientific and economic knowledge, and realization of the profound lack of such knowledge during the first Industrial Revolution. Our greatest hope for happier years to come lies in our ability, individually and collectively, to increase and apply this new fundamental knowledge. To fail diligently to seek, or to fail to apply, the new knowledge that will provide control of our scientific robots is the height of folly.

"Everybody hates a change. That is the one great thing that you must understand in the psychology of research. The human family in industry is always looking for a park bench along the road to progress, where it can sit down and rest, but the only park benches that I know of are immediately in front of the undertaker's shop."—Charles F. Kettering.

Introduction to Study of Yarn Structure With A Twist Tester

By E. R. SCHWARZ *

YARNS are essentially twisted structures and for this reason the measurement and study of twist in its relation to other yarn properties is important. Before this can be done intelligently, consideration must be given to the technique employed for twist determination and to the interpretation of the resultant data. Certain phenomena closely associated with twist measurement seem paradoxical to the uninitiated. To start with parallel strands, each one having a length of 100 yards, and to find after twisting them together, that the resultant plied yarn was 105 yards long is somewhat disconcerting. But this is what happens in the manufacture of certain yarns—notably in tire cords. Adequate apparatus for the study of this and the many other matters of interest in connection with yarns is important.

Modern Twist Testers

Many modern twist testers are designed to make possible the necessary measurements both conveniently and precisely. Whereas the old style instrument provided simply a rotatable clamp suitably geared to a dial for registering the total number of turns, it was not equipped to indicate change of length in the specimen. Usually the dial could be re-set only by turning the head times enough to return the dial scale to zero.

Consideration of the modern twist tester will show how much more desirable it is. Certain essentials have quite uniformly been met for these instruments both in this country and abroad. (See Figure 1.)

The dial can be instantly re-set and can be read to $\frac{1}{10}$ turn if desired. The non-rotatable head is made adjustable for any

* Assistant Professor of Textile Technology, Massachusetts Institute of Technology, Cambridge, Mass.

desired gage length up to as much as 20 inches, and, in addition, is arranged to be acted upon by a tension weight of any desired magnitude. This ensures uniform gage-length adjustment of

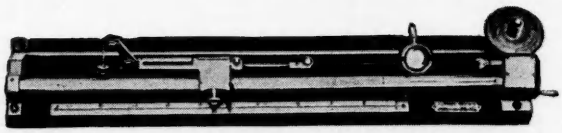

FIG. 1. A MODERN TWIST TESTER

the yarn by providing constant tension. It further allows the reading of changes in gage length to a fraction of an inch whether they are increases or decreases. It remains for someone to commercially equip the instrument with a device for recording these changes as ordinates of a plot with the twist as the abscissae.

Many instruments are provided with magnifiers so mounted as to enable the operator to view the exact condition of the yarn as the test progresses. These are of particular value when the twist in single yarns is being measured. A useful piece of apparatus for viewing yarns under test is the wide field stereoscopic binocular microscope (Figure 2). This can usually be inserted easily so as to be conveniently employed. Aside from the three-dimensional appearance of the yarn, the instrument does not reverse the direction of motion nor the image itself.

FIG. 2. STEREOSCOPIC BINOCULAR MICROSCOPE FOR USE WITH TWIST TESTER

Single-Twist Devices

The determination of twist in ply yarns is comparatively simple. Given a precise gage length under the right amount of controlled tension, it is only necessary to untwist the yarn until the component strands are parallel. This can be determined with some exactness. Single yarn twist, however, is very difficult to measure in similar fashion, except for long fibred materials. With cotton and short fibred yarns in general, only a short gage length can be used. Otherwise twist will be removed only locally (usually near one or the other clamp). One inch is the generally accepted gage, but Kapadia and Turner [1] advocate the use of ½ inch gage instead, noting, however, the necessity for careful sampling of the yarn. They state, further, that with a one inch gage, 100 observations are needed in order to be reasonably certain that the mean value will have a coefficient of variation of not more than 2 per cent.

Several devices are now available which are said to make the measurement of single twist quicker and more precise. While there appears to be merit in the idea back of these, care must be taken to confine their use to single yarns only. Serious errors are practically certain to be introduced if they are used for plied yarns. In these devices an arm rests against the yarn with definite and controlled pressure. The yarn is untwisted and twisted up again in the opposite direction by continuous turning of the twister head until the original pressure of the arm is restored. The total number of turns divided by twice the gage length is the desired twist. It is essential that no pressure be exerted on the yarn at or near the time when the fibres are most nearly parallel. Should the yarn be tensioned at this time, the fibres are apt to slip and either alter the gage length for the re-twisting, or cause failure of the yarn itself. In one device the lever is mounted horizontally and is removed from contact with the yarn by the operator before the critical point is reached. It must then be restored manually before the re-twisting has gone too far.

Three similar devices operate on the pendulum principle. The pendulum swings parallel with the yarn axis in two arrangements, and at right angles to the yarn axis in another.

One advantage of this principle (when properly adjusted) is that the pendulum hangs vertical without pressing against the yarn during the critical period and is automatically picked up by the yarn as it straightens out again. The proper final position of the pendulum may be read from a scale, or may be indicated by the completion of an electric circuit through a lamp, bell or buzzer.

These techniques are obviously superior to the one sometimes employed, of having the yarn under tension by means of a weighted movable clamp and noting the turns of the spindle necessary to remove sufficient twist to allow the yarn to rupture under the applied load.

Turns vs. Twist Per Inch

Throughout the study of twist, the total number of turns must be carefully distinguished from twist per inch. Evidently the former is independent of elongations and contractions, while the latter must be computed after consideration of length changes.

Suppose two single yarns are each twisted left-handed (helix running up to the left) 30 twists per inch, and that they are then plied to form a yarn containing 18 twists per inch right-handed. Now if 10 inches of single in each case are used, there will be 300 total turns in each length of single. If the contraction in plying amounted to 6 per cent., then the length of the plied yarn would be 9.4 inches, and it would contain closely 169 turns. For each turn that was inserted in the plied yarn during its formation, there was (theoretically) one turn removed from each of the singles. Thus there would nominally be 131 turns remaining in the single as it existed in the plied yarn. If the original length of 10 inches is assumed to continue—but in a helix rather than a straight line—then the single after plying will contain 13.1 twists per inch. Such a condition is not the actual one, as micro-examination of certain plied yarns by Bartlett and Smith [6] has shown; but the error is small in most cases. Evidently this is not the result obtained by subtracting the plied twist per inch from the original single twist per inch, which gives 12. The difference between these two values, as

Haven [2] points out, appears to increase as the single twist (or twist multiplier) increases. This he states to be due probably to increasing inter-yarn friction as the twist becomes greater. The upper limit of twist is not yet definite.

Relation of Helix Angle to Balance

In addition to the slight error due to change of length in the single as it is partially untwisted, is the discrepancy between the theoretical and actual conditions, introduced by the fact that because of the constraint of the singles by the ply structure, the former are not free to turn. The constraint increases as the ply twist increases and produces a condition of stress in

TABLE I

Multiplier	Actual single twist (before plying)	Single twist (determined from ply)	Ply	Actual ply twist	$T = c\sqrt{\text{yarn no.}}$	$T = \frac{t}{\sqrt{N}}$
			2	5.03	5.66	5.53
			3	4.22	4.58	4.52
3.00	7.63	7.84	4	3.52	3.97	3.91
			5	3.34	3.55	3.50
			6	3.38	3.25	3.20
			2	6.05	6.55	6.14
			3	4.89	5.35	5.00
3.50	8.66	8.85	4	4.03	4.63	4.33
			5	3.79	4.15	3.87
			6	3.88	3.79	3.53
			2	6.80	7.50	6.90
			3	5.55	6.12	5.63
4.00	9.74	10.4	4	4.63	5.30	4.87
			5	4.46	4.73	4.35
			6	4.35	4.33	3.98
			2	7.63	8.43	8.06
			3	6.23	6.87	6.56
4.50	11.36	12.4	4	5.61	5.96	5.68
			5	4.97	5.35	5.07
			6	5.03	4.87	4.64
			2	8.58	9.36	9.03
			3	6.86	7.64	7.35
5.00	12.71	13.03	4	6.12	6.62	6.37
			5	5.73	5.92	5.68
			6	5.83	5.41	5.20

the yarn which makes "balance"* determinations vary somewhat. The tabulated data taken by Haven [3] from an M. I. T. thesis by Colman and Bissland, show the existence of this state for a series of very nearly balanced 7[s] cotton yarns. Optical examination of many balanced yarns and approximately balanced yarns by the author has shown that apparently an essential condition of balance is an equality of the helix angles in the component and final structures. When the helix angle of the fibres to the single yarn axis (as the single yarn exists in the ply) is equal to the helix angle of the single to the ply yarn axis, for example, a state of balance is closely attained.

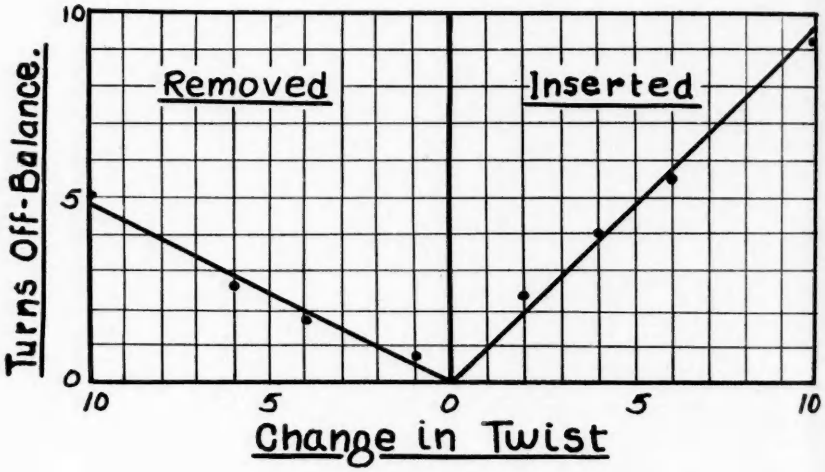

FIG. 3

Formulae for Required Twist

Preliminary work by Sawyer and Franks [4] carried out under the supervision of the author, shows that there is every prospect of obtaining a rather definite relationship between the degree of "off-balance" in a yarn and the degree of departure of twist from that obtaining in the balanced condition. (See Figures 3 and 4.)

* Balance—the condition of a plied yarn when the untwisting tendency in the ply is exactly equal to the resistance to twisting up further in the single.

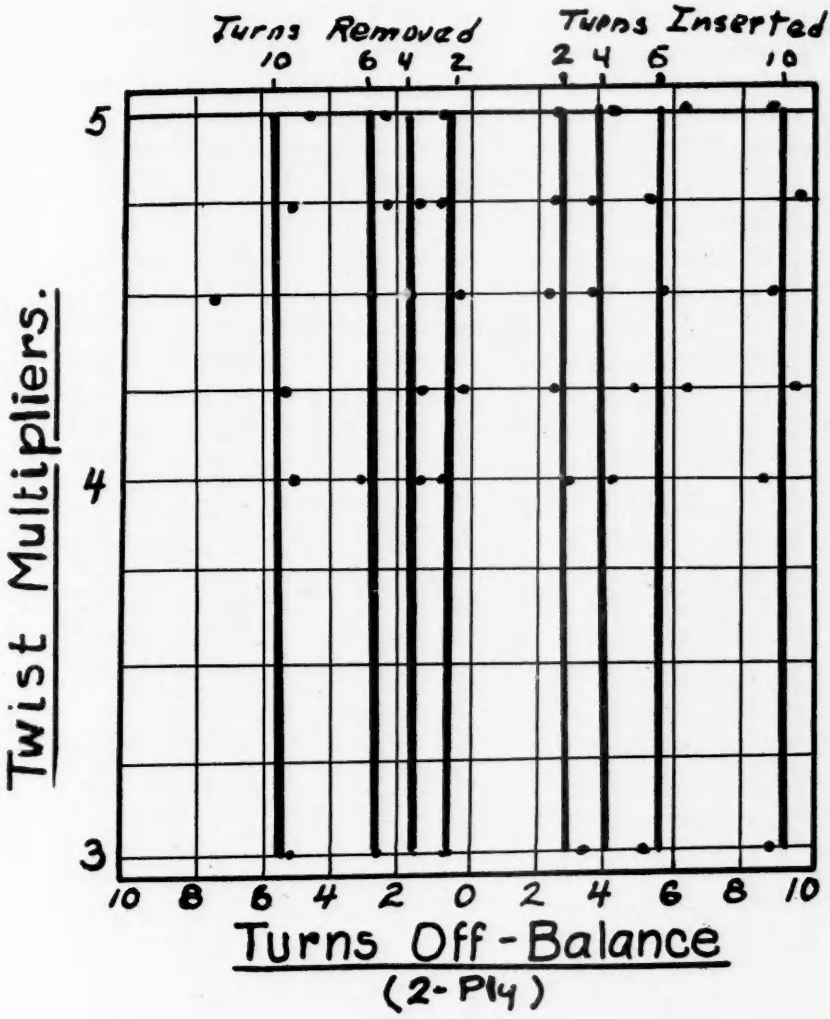

FIG. 4

It is further apparent from these same tests that a relation of the form suggested by earlier unpublished work of the author, namely

$$T = c\sqrt{\text{ply counts}}$$

where c = single twist multiplier
T = ply twist to form a balanced yarn

is sufficiently good to give a rough first approximation of the

required twist. Sawyer and Franks suggest an equation which, in some cases, is an improvement, as follows:

$$T = \frac{t}{\sqrt{N}}$$

where t = single yarn twist
T = ply yarn twist
N = number of plies in yarn

This formula is simple enough for mill use and is much better than a blind guess. Tabulated data showing the comparison of these formulae with the actual twist for certain of the 7^s cotton yarn already mentioned is to be found in Table I. Figure 4, resulting from the author's analysis of Sawyer and Frank's work, indicates that it may be expected that for a given removal or insertion of twist, the degree of "off-balance" tends to be constant for a given ply, regardless of the twist multiplier. Sawyer and Franks also show it to be constant for a given multiplier, regardless of ply, through 6 ply.

As would be expected, the degree of "off-balance" is less for removal of twist than for insertion of a like number of turns. The discrepancy existing in the case of the six-ply yarn (Table I) is undoubtedly due in large measure to the distortion usual in such a construction, as shown by the author [5] in a recent paper. Agreement between the formulae and the actual values cannot be expected to be perfect in any case, but the possibility of the use of a twist tester of good design to obtain data for the empirical derivation of a more nearly correct relationship will be apparent.

Plying Contraction a Function of Helix Angle

Optical analysis of yarn by the author [5] has shown that the contraction due to plying can be expressed as a function of the helix angle, and takes the form

$$\% \text{ Contraction} = 100\ (1 - \cos Q)$$

Conversely, the elongation may be written

$$\% \text{ Elongation} = 100\ (\sec Q - 1)$$

Evidently the elongation and contraction of plied yarns may also be measured through the instrumentality of a twist tester in its usual or somewhat modified form, as may be required.

One such test by Bartlett and Smith [6] furnished data from which the plot of Figure 5 was made. They mounted the rotating head of a twist tester so that a gauge length of 10 feet was obtainable and substituted a light travelling carriage, moving along a scale, for the usual end-clamp. A tension of approximately one-fourth of the yarn strength was applied by means of a dead weight suspended by a light thread passing over a pulley. The motion of the carriage was noted after the addition of each 100 turns, and these data were converted to per cent. contraction. The smoothness, spacing, and shape of the curves obtained by plotting these percentages against the corresponding twists per inch are worthy of note. (See Figure 5.) It should be noted that, in every case, an elongation occurred initially, and that this was greatest for the two-ply and diminished successively for the three-, four-, and six-ply constructions.

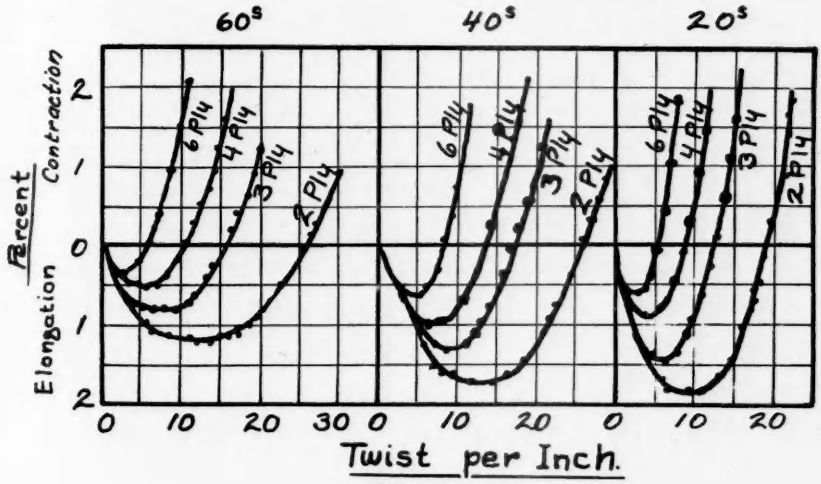

FIG. 5

When such yarns are untwisted there will be elongation up to a certain point. For a short period, during which further twists are removed from the ply, there is no change in length. Finally there is a small contraction. In none of the cases shown, does this contraction approach the elongation in magnitude. It is caused by the increasingly rapid contraction of the single yarns, since removal of ply twist adds twist to their structure. (Compare Figure 6.)

With the greater degree of freedom afforded the singles by the removal of the ply twist, some of the accumulated potential energy of torsion, hitherto restrained from becoming kinetic, actively inserts the twist necessary to relieve the stressed condition in the single and accounts for the rapid contraction of the latter.

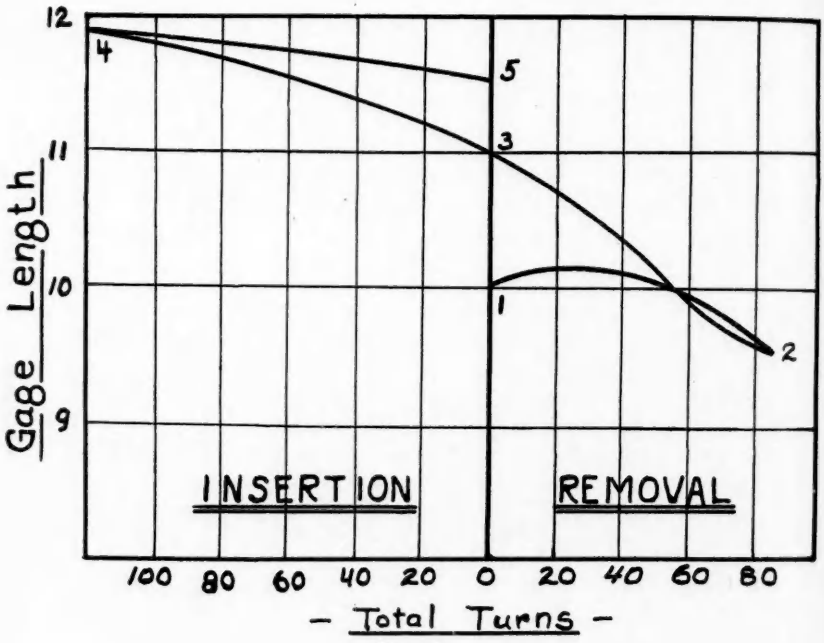

FIG. 6

For super-twisted tire cords, where the resultant yarn is a cabled structure, the singles and the first plies are twisted in the same direction and to a high degree. The cable, or cord twist is opposite in direction. Hence, when such a cord is untwisted, the same cycle as that just described is passed through with the exception that the additional twist inserted into already highly twisted plies and singles augments the usual contraction. This contraction, thus, is frequently more rapid and of greater magnitude than is the cord elongation. The cord elongates throughout its untwisting; but the contraction of the plies aided by their component singles, eventually completely masks this. The cycle is shown diagrammatically by Gurney and Davis [7]

and Figure 6 gives the essentials of their representation of the sequence of events.

"Corkscrew" or "Strand Deviation" Testing

A further example of the use of the twist tester for yarn analysis is to be found in Haven's discussion [8] of an M. I. T. thesis by Kane and Behar, conducted in 1928. Without going into unnecessary detail here, they mounted the twisting head on a special board. Provision was made to pass the component strands of a plied yarn over a guide rail which formed a portion of a circumference centered at the nose of the rotating clamp of the twist tester. With proper weights applied to the strands, their final lengths may be determined and indicated on a vertical chart against which they rest. (See Figure 7.) The device is

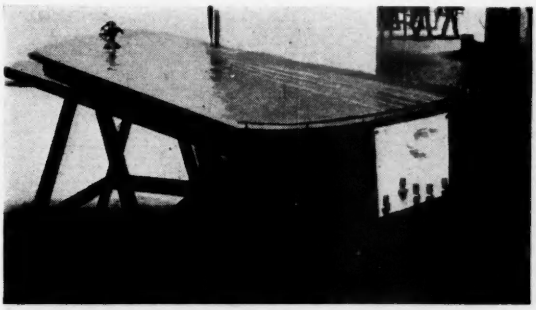

FIG. 7. CORKSCREW INDICATOR

intended to measure "corkscrew," a term which the author believes should be confined to cored yarns. Thus restricted, a corkscrewed yarn is one which is made up of a core consisting of one or more yarns, either parallel or twisted about each other, around which other yarns "tendril." Obviously all yarns of seven or higher ply will be inherently corkscrewed, regardless of tension conditions in the component strands. A single yarn as a core is obviously the worst case and 20, 21, 22, 23, 24, 25, 40, 42, etc., plied yarns will normally be such constructions. The core may be formed by different yarns or groups of yarns at different points, which is not so bad a condition from the standpoint of strength. The conditions may be shown, whatever they are, and the resultant "map" of the final positions of the strands

after test on the so-called "corkscrew" board, when interpreted in the light of micro-analysis of plied yarn structure (see reference 5) can be most informative. Haven [8] notes the individual core effect and states that corkscrew may "be called 100 per cent., namely, while one strand is entirely straight, the others are tendriled about it . . . ," but he then discards this definition and in two different places details a method of measuring which gives a value of 6.4 per cent. for a seven-ply yarn which, almost without exception, will have a single unit core. The author believes that this latter treatment has value and a place in the consideration of yarn structure, but it should not be termed "corkscrew." Since what has been measured is really the total departure of the strands from a condition of equal lengths or tensions, and consequently will be neither an indication nor a measure of the "tendril effect," a different designation such as "strand deviation" would seem preferable. Whatever the point of view, however, the required measurements are made most conveniently by a simple adaption of the twist tester.

Other applications of the twist tester will suggest themselves to the research worker. The use of the instrument as a *twister* rather than as an *untwister* should be emphasized, since too little study has been devoted to yarn structure from this angle. No factor in regard to yarn manufacture and utilization is more important than twist, and a good twist tester, therefore, becomes an extremely valuable instrument in any textile laboratory, however pretentious, or however modest it may be.

References

[1] Kapadia and Turner. "The Determination and Variation of Twist in Ring Spun Cotton Yarns."—J. T. I., May, 1931, p. T274.

[2] Haven. "Mechanical Fabrics," New York, John Wiley and Sons, Inc. (1932), p. 631.

[3] Ibid., p. 633–636.

[4] Sawyer and Franks. "Unpublished Research at M. I. T." (1929).

[5] Schwarz. "Micro Analysis of Yarns," Textile World, April 18, 1931 and May 23, 1931.

[6] Bartlett and Smith. "An Investigation of the Contraction of Certain Plied Yarns Due to Twist," M. I. T. Thesis (1923).

[7] Gurney and Davis. "The Elastic Properties of Yarns, with Special Reference to Tire Cords," J. T. I., October 1930, p. T463.

[8] See (2), p. 213–216 and a repetition of the method on p. 443–447.

Empirical and Scientific Knowledge in the Textile Industry

By CHARLES H. CLARK

REITERATION in publications of U. S. Institute, and by speakers at its meetings, of the backwardness of the domestic textile industry in the utilization of scientific research, has been interpreted in some quarters as a serious reflection upon the technical progress and status of the industry as compared with other old industries. The fallacy of such interpretation is refuted in this paper by Mr. Clark, presented last March before Committee D–13 of the A. S. T. M.

THE history of the textile industry for the last 150 years, or since the beginning of the industrial revolution, demonstrates that manufacturers, considered collectively, have engaged in practices that many modern industrialists regard as the mark of a backward industry. The history of the industry shows, first, that technological development has been due mainly to try-and-reject, or empirical, methods. Secondly, that many of the most basic and important textile machines and processes, and practically all that were the fruit of scientific research, were the work of men having no direct connection with the industry.

Acceptance of these claims is not a reflection upon the technical progress of the industry, nor upon its present stage of scientific development and efficiency, as compared with most other equally old industries. Certainly it compares very favorably in these respects with the paper, the tanning, and the iron and steel industries. In fact, until very recently these other old industries had been quite as dependent as the textile industry upon outsiders for their new fundamental discoveries, and quite

as closely confined to try-and-reject methods for technological inventions having their origin within these industries.

All of these industries, including textiles, had their beginnings in pre-historic times, and many of their processes are basically the same today that they were thousands of years ago. During the long era of hand manufacture a multitude of workers sought by thousands of experiments to lighten their labors and win rich rewards, and during the 17th, 18th, and well into the 19th century, numerous improvements in hand machines were devised and utilized. This inventive period actually overlapped the industrial revolution, and for various reasons that are not of importance in this connection, hand spinning and weaving were practiced in this and European countries on a considerable scale during the first quarter of the last century.

Inventors of the "Industrial Revolution"

The "industrial revolution" wrought surprisingly few changes in basic principles of hand spinning and weaving, and even fewer in the basic principles of the other old industries mentioned; furthermore, a careful study of the great textile inventions of that period and of their inventors fails to disclose conclusive evidence that any of the latter had the advantage of scientific training, or that any of these inventions qualify as the products of scientific research. Many of these inventors, in fact, had had no prior connection with the textile industry, and most of those who were textile men were merely skilled spinners, weavers or other artisans.

John Kay, who invented the fly-shuttle in 1738, was a hand weaver, and so was his son, Robert Kay, who in 1760 invented the drop box. Sir Richard Arkwright, who is credited with the invention in 1769 of the water spinning frame, and who was later legally despoiled of his patent, was a barber by trade, but his ingenious mechanical frame of mind impelled him to abandon cutting hair for spinning cotton, and his business ability aided him in amassing a large fortune. Arkwright embodied in his machine the flyer invented by Leonardo da Vinci, a 15th century artist, and the drawing rolls, whose invention in 1739 is variously

credited to Lewis Paul and John Wyatt, but by British historians is generally credited to the latter because Paul was a foreigner. It is not impossible that he was an American, for British historians of the late 18th and early 19th centuries displayed a peculiar pleasure in hiding the identity of American inventors and inventions. However, Lewis Paul has sufficient fame as the inventor in 1748 of the cylinder card for wool and cotton, but there is no evidence that he was anything but a skilled mechanic. James Hargreaves, who in 1770 invented the spinning jenny, was a hand weaver who visualized the possibility of operating a spindle vertically when a high wheel that had been tipped onto its right-hand side continued to run freely. Samuel Crompton, who invented the cotton mule in 1779, was a hand spinner of unusual mental equipment, but could not by any stretch of imagination be termed more than a skilled technician. The Rev. Dr. Edmund Cartwright, who invented the power loom in 1785, had never seen a hand loom in operation until after his first model was finished.

Other Non-Textile Inventors

In contributions of non-textile men, and in the preponderance of try-and-reject methods the initial development of the chemical processing end of the textile industry during the industrial revolution was closely parallel to that of the spinning and weaving branches. Cylinder printing was invented in 1788 by a Scotchman named Bell who must have been a clever mechanic as well as a block printer. Discharge printing was also of Scotch origin, and by further try-and-reject methods was perfected by Peel & Co., famous cotton printers of Church, England. Resist printing was invented in 1802 by a man named Grouse, a traveler for a London firm of chemists, who was credited with "possessing little practical and less scientific knowledge." Transfer printing was invented in 1808 by Jacob Perkins, an American inventor of a similar process for the duplication of plates for printing bank notes.

We know that Eli Whitney who invented the cotton gin in 1794 was something more than a skilled mechanic, but he had

never seen cotton ginned by hand until he went to Charleston, S. C., that year, and was connected in no way with the textile industry. Samuel Slater, father of the cotton mill industry in this country, who started business in Pawtucket, R. I., in 1790, was a skilled technician and a machinist; he, as well as Francis Lowell, who with Patrick Jackson started the first complete cotton factory system in Waltham, Mass., in 1812, smuggled from England mental pictures of textile machinery, thus evading the embargo on the exportation of such machinery.

It is possible that Charles Danforth who invented the tube-frame, or speeder, in 1824 and the cap spinning frame in 1828, was more than a skilled machinist; at least, he had the business ability to later accumulate a fortune as a textile machinery builder in Paterson, N. J. John Thorp, who also took out a cap spinning patent in 1828 and invented the basic principle of ring spinning the same year, was merely a skilled technician and machinist.

Beneficiary of Non-Textile Research

Since the first quarter of the 19th century the basic principles of spinning and weaving, of bleaching and printing have persisted. During the last 75 years the development of radically new processes has been greatest on the chemical side of the industry, and with few exceptions the most important of these discoveries have been the product of scientific research by men outside of the textile industry. Coal tar dyes, mercerization and synthetic fibres are striking examples. Sir William Henry Perkin, whose discovery of mauve in 1856 laid the foundation of the coal tar derivative industry, was a chemist having no connection with the textile industry. Adolph von Bayer, who worked out a formula for synthetic indigo in 1880, and the Badische Co., which later developed the process and product on a successful commercial basis, were also outside of the textile industry. The mercerization process which carries John Mercer's name, but the lustering possibilities of which he failed to discover in 1844, was finally developed by scientific research methods some 50 years later. Count Chardonnet, who laid the

foundation of the synthetic fibre industry in 1884, was another of the great chemists who through scientific research have added materially to the diversification and profit of the textile industry.

The development during the last 50 to 75 years of the mechanical and physical side of the industry has been mainly in the refinement of machines and processes, making possible greatly increased production and marked reduction of manufacturing costs. The nature of these improvements is too well known to textile men to require review here.

It has been shown that the great textile inventions of the industrial revolution were mainly the product of skilled machinists whose inventive methods were those of the try-and-reject character, and that a surprisingly large number of these inventions were the product of men having no direct connection with the textile industry. It has also been indicated that most of the basic textile discoveries and inventions that were the result of scientific research must also be credited to non-textile men. I think it will be agreed that in these respects the physical and chemical development of the industry during the last half century has differed but little from that during and immediately following the industrial revolution. Well, what of it, you may inquire? And I echo the sentiment insofar as it concerns the manner in which the industry attained its present marvelous mechanical and chemical development. I do so notwithstanding evidence that textile manufacturers then as now failed to take full advantage of the scientific knowledge available and failed individually and collectively to take full advantage of the opportunities to increase that knowledge.

Baines, the English historian of the early cotton manufacture, publishes a glowing description of the scientific status of the industry in 1835, which is refuted by his history of early textile inventors and their work; in fact, his picture would be almost as exaggerated for the industry of 1932 as it was for that of 1835. It follows: "A printing establishment, like a cotton mill, is a wonderful triumph of modern science; and when the mechanical and chemical improvements of both are viewed together, they form a splendid and matchless exhibition of science applied to the arts, and easily account for a rapidity of growth and

a vastness of extension in the manufacture, which has no parallel in the records of industry."

Blissful (?) Ignorance of Fundamentals

President Hoover has stated that "Unless pure science fills up the reservoirs of basic knowledge, in order that the mental equipment of humanity as it exists today can use it, the pace of our development may slow down during the century to come." It is equally true that unless an industry applies the results of pure science and itself maintains a constant flow of new fundamental knowledge the pace of its development must slow down. It is unnecessary to attempt to review the enormous expansion in scientific knowledge during the last half century. It should also be unnecessary to produce the detailed evidence proving that the textile industry has failed to make equal scientific progress and has failed to take full advantage of the scientific tools that have been available. Mechanically it is as highly developed as most of the modern industries. It might be demonstrated that its basic knowledge of fibres is no more incomplete than that of the electrical industries of electricity, but the striking difference between the textile industry and practically all modern industries is in its apparent indifference to research for new basic knowledge. Possibly it was the textile industry that was the subject of the old adage, "Where ignorance is bliss, 'tis folly to be wise." Certainly we of the textile industry must admit profound ignorance of fundamental facts regarding all fibres and many processes commonly utilized. Lack of this knowledge is a serious handicap in efforts to develop new products and new uses for existing products. If this is bliss, then it is folly to attempt, as do most modern industries as a normal business activity, to utilize scientific research for the development of new products.

Balancing Production and Consumption

Meanwhile, automatic machinery, labor saving methods in its operation, and highly efficient mill management have expanded the productive capacity for existing products of prac-

tically all branches of the industry beyond any but abnormal consuming demands. There are at least three methods of meeting such an emergency: One is cooperative effort in balancing production of existing products to the demand for them with the objective of controlling prices; another is cooperation in scientific research with the objective of developing a sufficiently large variety of salable new products to provide work for a large part of existing machinery, and to render obsolete that part of existing equipment that cannot be profitably employed upon old and new products; the other is more efficient merchandising methods.

It is illegal to cooperate for the control of production and for price fixing if anti-trust laws are literally interpreted and enforced, but it is not illegal to cooperate or to combine for the development of new basic knowledge that may rehabilitate the industry and be of equal advantage to manufacturer and consumer. It is not illegal to improve merchandising methods, but without something new in fabric, finish or design, or without the development of new uses for existing products, the merchant is practically powerless largely to increase sales; moreover, the merchant and the industry must expect to face a further expansion in production due to improved management methods and to plant re-equipment.

Possibilities of Scientific Research

Attention has already been drawn indirectly to expansion in sales of new products and to displacement of old products by fast dyes, the mercerization process and synthetic fibres. It is impossible to predict what in the way of new textile products and finishes might result from scientific textile research, but we know that scientists in various parts of the world are engaged in attempts to synthesize wool and silk from protein bases that, unlike rayon, could be chemically processed the same as the natural fibres. We may be confident that rayon far superior in strength, elasticity and other desirable properties will eventually result from continued scientific research. We can be assured that research on the natural fibres eventually will provide sufficient knowledge regarding their chemical and micelle

structure to make possible more efficient and controlled processing and also to disclose new yarn and fabric finishes.

The literature of textile machinery is much more complete than that of textile fibres, yet we know little of what actually takes place in the cotton card and less regarding the drafting process in the other preparatory processes and the spinning frame. Lacking this knowledge there can be no efficient control of fibres in the drafting processes. It is possible that the thousands of inventors and ingenious mechanics, who have contributed during some 150 years by try-and-reject methods to the improvement of cotton machinery, have progressed as close to perfection as might have been possible by scientific methods in a shorter time. But, while this may be true, I can find reasonable ground for doubt in the fact that the modern perfected machine system of cotton spinning has failed completely to duplicate one of the three basic principles of hand spinning, and to approximate that principle has been obliged to utilize a set of 10 to 15 distinct machines, with the same number of draftings and an enormously greater number of doublings.

I refer to the fact that, before throwing the bobbin to insert twist in the yarn, the hand spinner not only drafted the fibres with the right hand, aided by the weight of the bobbin and the twist, but also used the left hand to prevent extra fibres from entering the yarn. In other words, the skilled hand spinner selected just the right number of fibres to produce a yarn of the desired fineness. I freely admit that with from 50 to 75 million cotton fibres in a pound of yarn, the fractionation and selection of just the right number of fibres to fit the diameter of a yarn of any number is a problem that is likely for sometime to continue to puzzle our most ingenious inventors. I am confident, however, that if this ultimate goal of high drafting is ever attained it will be with the preliminary aid of scientific research.

I realize that in linking the possibilities of scientific textile research with such a practical everyday process as cotton spinning, the basic principles of which have not changed in a hundred years, I am courting the charge of being visionary. I will, therefore, refrain from advancing theories as to the possibility of producing strong and even yarns and fabrics without twist, of producing fabrics for industrial and other uses without weaving,

of greatly improving and expanding the wool felting process for production of fabrics without spinning or weaving, and of mentioning other textile possibilities that would cause the average practical textile man to classify scientific research as a modern form of alchemy.

An Example of Non-Scientific Method

I cannot refrain at this point from taking a crack at those practical textile men who regard scientific textile research as theoretical bunk. Certain men of this type engaged in cotton, worsted and spun silk manufacture have been wont to claim that if they could be assured of an adequate supply of staple of any desired length and fineness they would "show the cock-eyed world" yarn that is yarn. Now in cut rayon staple they have available almost any desired fibre length and fineness, with, of course, the characteristic limitations of rayon as compared with natural fibres. But, have these practical manufacturers studied this new raw material in a practical or scientific manner with the objective of selecting just the right length and fineness of staple to produce a yarn of just the right number, evenness, strength and other qualities? If they have the result is jealously guarded. It is extremely doubtful that cotton men have considered the question of denier unless they have spun mixture yarns, for most cotton buyers, unlike wool and silk buyers, fail to take account of fineness as a factor in cotton character. No, these practical manufacturers have apparently been unconscious of facing a new problem other than within the limitations of their existing machine equipment. The spun silk man has ordered staple lengths suited to his machines, and the worsted man for his, both taking fineness of staple into account, while the cotton spinner has ordered the much shorter lengths suited to his roll settings and with little consideration of denier.

I am not going to bore you with a detailed description of the manner in which a manufacturer of trained scientific mind would approach and solve a new problem of this kind—for it is a new problem. Suffice it to say that, with a staple of any desired length selling at the same cost per pound, plus the normal price difference for denier, he would be most interested in de-

signing yarns that would meet a ready demand at a reasonable profit and that would be in a class apart from existing staples. He would then design special machinery for their production, or select from existing textile machinery equipment that would approximate the desired result. He would then, I feel certain, consult with manufacturers of rayon staple as to the possibility of improving their product and developing staple of cross sectional character, denier and other qualities that would broaden the market for such yarns and fabrics.

Summary

In all this there is convincing evidence for the open-minded man that technical progress of the industry depends not only upon adequate utilization of scientific methods, but upon cordial cooperation between the industry's staff of practically and scientifically trained men. Each has something to give that the other usually lacks, and for either to refrain from giving freely is to mark him as a "poor mixer," or as jealously guarding fancied secrets. If the former, he is unfortunate; if the latter, he is a back-number, for there are few textile secrets today that are other than undiscovered knowledge.

"The application of existing knowledge to the problems of industry does not constitute 'research'; true research seeks new knowledge, frequently with no utilization in view."—Willis R. Whitney and L. A. Hawkins in "Profitable Practice in Industrial Research."

Research Miscellany

Refrigeration vs. Carbonization

MECHANICAL processes for the removal from wool of spiral and similar burrs are inefficient; even the carbonizing process is seldom 100 per cent efficient and is liable to weaken and discolor the fibre. At the Lowell (Mass.) Textile Institute, under supervision of Prof. E. H. Barker, there is in process of development a method of burr removal that is said to involve refrigeration, following wetting down and extraction of the wool, the frozen fibre then being run through crushing rolls and afterward through a duster. The basic principles involved have not been disclosed, and probably will not be until it is demonstrated whether or not the process can be made a commercial success. It is interesting to note that a Californian, having no direct connection with wool manufacturing, originated the idea.

New Officers of A. A. T. C. C.

AT the recent annual meeting of the American Association of Textile Chemists and Colorists, held in Greensboro, N. C., the following officers were elected: President, Dr. Robert E. Rose, director, technical laboratory, E. I. du Pont de Nemours & Co., Wilmington, Del. Vice-Presidents, Alex. Morrison, chemist, American Woolen Co., Andover, Mass.; William H. Cady, chief chemist, U. S. Finishing Co., Providence, R. I. Treasurer, William A. Moorhouse, New England manager, National Aniline & Chemical Co., Boston, Mass. Secretary, A. Newton Graves, Franklin Process Co., Providence, R. I. Councilors elected were W. D. Appel, chief Textile Section, Bureau of Standards, Washington, D. C.; Hugh Christison, chemist, Arlington Mills, Lawrence, Mass.; Carl Z. Draves, chemist, Ludlow Mfg. Associates, Ludlow, Mass.

Cellulose From Bagasse

WITH dilute nitric acid as a pulping agent, chemists of the U. S. Department of Agriculture are reported by Secretary Hyde to have developed a process for making high-grade cellulose from bagasse, the waste from cane sugar manufacture. Cheap sources of nitric acid are claimed to make the process commercially feasible, but practical problems of manufacture must be worked out before this additional source of cellulose becomes available for rayon production.

An Example Worth Following

"'BOSS KET'—otherwise Charles F. Kettering, General Motors research wizard—keeps 40 experts busy devouring every book and periodical, in all modern languages, likely to contain any new idea, any new knowledge, any new wrinkle along mechanical or other scientific lines related in any way to the engineering, metallurgical, chemical lines in which he is interested. His readers have a good idea of what he already knows, and draw to his attention only such things as they believe to be original. Sometimes he will be asked to read only six sentences in a heavy tome. Often a thesis in a technical journal can be boiled down to a few dozen words.''—B. C. Forbes in the *Boston American*.

Ramie Redevivus

EVERY few years someone pops up with a new process or machine for decorticating or degumming ramie—sometimes they call it rhea. A company is formed to exploit it; securities are sold; it may actually place its product on the market; then it fades away. Millions of dollars have been lost in such ventures. Ramie is a beautiful fibre when properly prepared for spinning by cheap but skilled Chinese hand labor. Its length, its lustre, its strength when wet, and when, wet or dry, it is subjected to tension approximately in line with its axis, are admir-

able qualities. It will not, however, "wear seven times as well as wool, and several hundred times as well as cotton," as is claimed in "Technocracy's Question," by Wayne W. Parrish, in the *New Outlook*. It will not, because it is weaker than wool, cotton, or any other commonly used textile fibre when subjected to acutely angular tension. When knotted, a slight pull on the knot will break a coarse ramie string. The cause had been suspected for many years, but was not definitely located until Prof. Schwarz at Massachusetts Institute of Technology studied ramie fibres with a high-powered microscope and polarized light. His microphotos showed what, to the layman, look like threads loosely running around the fibre singly and in groups, and always at or close to right angles with the fibre's axis. They looked like "faults" in the micelle structure, and X-ray diffraction diagrams proved this surmise to be correct. These "faults," or digressions from the normal micelle linkage parallel with the axis of the fibre, are responsible for the fibre's weakness when subjected to tension not in line with its axis. One of these microphotos of ramie in polarized light may be seen opposite page 107 of U. S. Institute's book, "Textile Research: A Survey of Progress."

The Virtues of Wool

DR. S. G. BARKER, director of the British Research Association for the Woollen and Worsted Industries, Leeds, Eng., has been moved by the ignorance of the general public as to the inherent scientific differences between sheep's wool, which has a protein base, and so-called "artificial wool," which is a cellulose derivative having a vegetable origin, to summarize the virtues of wool in non-technical language, as follows:

"(1). Wool absorbs water more readily than any other textile fiber and holds it longer. There is no tendency for it to deposit moisture on the skin, with consequent discomfort to the wearer, and liability to catch cold with small changes in atmospheric conditions.

"(2). Wool generates heat in itself. When water is absorbed heat is generated by the wool itself, thus creating a healthy glow on the skin when the initial perspiration is absorbed by a freshly aired garment.

"(3). Wool is the best insulator for heat. It has a low heat conductivity and the beard of fine fibers on a wool garment entrap air so as to form a healthy insulating layer next to the body and maintain it at an equable temperature.

"(4). Wool is light. A wool fiber is lighter in weight than any other textile fiber of the same thickness.

"(5). Wool is perfectly elastic. Wool makes a perfect complete recovery from strain and has the extraordinary power of taking up large extensions without rupture or permanent damage.

"(6). Wool transmits the health-giving ultra-violet rays. Wool is the correct wear for sun bathing. For effective and lasting good, the body must also be warm.

"(7). Dyestuffs are less liable to fade on wool and are faster on wool than on any other fabric.

"(8). Wool is the natural body covering. Designed by nature as the bodily protection for an animal next its skin, it forms the ideal wear for the human body.

"(9). Wool is durable. Exposed to weathering, wool is more than three times as durable as any other fabric.

"(10). Wool is strong. A wool fiber is equal in tensile strength to a filament or wire of equal dimensions made of iron or other metals.

"(11). Wool is almost non-inflammable, and, further, is an effective silencer for noise and vibration.

"(12). Wool can be felted. No cellulose fiber can be thus processed."

"A well-organized research department manned by trained scientific men is the manufacturer's insurance against the loss of his 'place in the sun.'"—Charles M. A. Stine.

Abstracts and Bibliography

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Mr. E. D. Walen, Prof. Louis A. Olney.

The Arrangement

Abstracts and Bibliography are arranged alphabetically by major subject under the following classifications:

I. Fibres (Synthetic and Natural) and Fibre Analysis.

II. Yarns and Fabrics.

III. Chemical and Other Processing (Not Otherwise Classified).

IV. Research Methods and Apparatus.

V. Economic Research and Miscellany.

Subjects are followed by name of author, and the abbreviated or complete title of the publication is followed by the year, volume, issue number or date, and the page number or numbers.

A key to abbreviations of publications abstracted was published in Vol. III, No. 1, Nov., 1932, pp. 58–9, and should be preserved for reference as it will not be published again in this volume. Abbreviations of additional publications abstracted will be published in issues of their initial use.

Abstracts

I. Fibres (Synthetic and Natural) and Fibre Analysis

Asbestos: Structure of, An X-Ray Study. B. E. Warren. *J. Ind. and Eng. Chem.*, April, 1932, P. 419.

Because of its unique physical properties asbestos is one of the most important minerals in the world and is largely used in textiles. The paper describes briefly the results of x-ray study of the asbestos compounds to show how the fibrous nature of the material and the strength and flexibility of the fibres may now be readily understood in terms of the crystal structure. The work described was carried out by Dr. Warren of the M. I. T. Department of Physics and describes the structure of diopside, tremolite, and chrysotile. Several diagrams and two x-ray diffraction photographs are given. The article is of particular interest in connection with the x-ray analysis of other textile fibres certain phases of which were described in Textile Research: A Survey of Progress, notably by Dr. H. DeW. Smith. (S)

Animal Fibres: Reaction Between, and Ammonium Chloride Solutions. A. E. Porai-Kochitz, E. G. Levine and V. S. Remennikova. *Izvestiya Tekstil. Prom. Torgov.*, 1931, Vol. 10, Nos. 3–4, P. 81–2; *Chim. et Ind.*, 1932, 27, 909–10; *Chem. Abs.*, 1932, 26, 3930.

Meyer (*Chem. Abs.*, 22, 502) showed that wool and silk can absorb the anions of acid dyes and of various mineral and organic acids only up to a "limit of absorption" which is 0.008 g. for wool and 0.002 g. for silk, per g. of fibre. P–K found that animal fibres treated at the boiling point with solutions of neutral salts of acid and substantive dyes do not absorb the anions of these dyes, but, if the cation is removed from the field of the reaction, dyeing can be carried out to the limit of absorption as established by Meyer. It was natural to expect that animal fibres would behave similarly not only toward dyes but toward all salts, the cations of which can be removed from the field of reaction, such as NH_4 salts, and the authors have shown that wool absorbs HCl from NH_4Cl solutions, with liberation of NH_3. In the present investigation, it was found that the amount of NH_4Cl fixed by the fibre becomes constant above a given concentration (600 per cent. of the weight of wool). The saturation limit of 0.008 g. per g. of wool was confirmed. For silk it was 0.00033, instead of 0.0002 g., the anomaly being possibly due to hydrolysis of the product or dissociation of the NHCO groups of the silk. (W)

Cellulose: Mixed Esters of. Freitag. *Kunststoffe*, 22: 110, May, 1932.

A short discussion is given of mixed esters of cellulose including mention of acetate-nitrate, acetate-formate, acetate-propionate and acetate-butyrate. The author speaks of acetate-formate being prepared by pretreating cellulose with formic acid and subsequently acetylating. The other

organic esters are said to be prepared by esterification with acetic anhydride, acetic acid, a catalyst and either propionic or butyric acid, or by simultaneous reaction on the cellulose with the two acid chlorides. The acetate-propionate is recommended for the insulation of electrical cables, for lacquers or plastic masses, or as components of these. (Copied complete from *Eastman Kodak Bull.*, Sept., 1932.) (S)

CELLULOSE ACETATE: USE OF SULFUR DIOXIDE IN THE MANUFACTURE OF. V. E. Yarsley. *Brit. Plastics*, 3: 284–6, December, 1931.

In the manufacture of cellulose acetate by the usual processes in which acetic acid is used as a diluent, an appreciable part of the manufacturing cost is incurred in the recovery of the acid from the dilute solution resulting after the precipitation of the cellulose acetate with water. All or part of the acetic acid required for this purpose may be replaced by liquid sulfur dioxide. It is removed from the acetylation mixture by simple distillation and recovered for further use by condensation. At the same time the cellulose acetate is precipitated as a white fibrous mass. It also offers possibilities of control during acetylation in that the temperature of the reaction mixture may be reduced by allowing some of the sulfur dioxide to evaporate. It also has a favorable catalytic effect on the reaction. (Copied complete from *Eastman Kodak Bull.*, June, 1932.) (S)

COTTON CELLULOSE FIBRE: MICROSCOPY OF. R. N. Titus, C. J. Staud, and H. LeB. Gray. *J. Chem. Education*, Jan., 1932, P. 114–21.

An author's summary states: "There is given in this paper a brief review of the general growth process by which the cottonseed hair is formed. This is followed by a discussion of the composition of the cell wall and the microscopy of the growth of the secondary cell wall, with an outline of the mechanism by which these processes may take place. There is a short section devoted to the subject of the so-called 'dead hairs' and a brief statement of the possible theoretical mechanism of their formation. The subject of the desiccation of the cotton fibre is also discussed. A short section of this paper is devoted to the cuticular layer. A section is concerned with a general review of the present conception of the cause and formation of the spiral form of the desiccated fibres. The work done on the study of the porosity of the cotton fibre is also presented. Some of the literature dealing with the correlation between the areas of strain in the living fibre with the twists of the desiccated fibre is reviewed. Finally, the theoretical considerations attempting to explain why a desiccated fibre cannot be restored to its original form are given." (S)

FIBRES: ELASTIC PROPERTIES. K. H. Meyer, G. v. Susich and E. Valko. *Kolloid Z.*, 1932, 59, 208–16.

Röntgen investigations of the influence of temperature, swelling and contraction on the elastic properties of rubber, gelatin, wool, silk and cellulose derivatives are discussed. The elastic properties are attributed to the presence of long principal valency chains which, in the stretched material, are oriented in the direction of the stretching force. An essential part of the heat content of these chains consists in the rotation and deformation movements of the individual atom groups transverse to the axis of the molecule, while the valency vibrations in the direction of the axis show only a small heat content. The transverse motions lead to irregular impact

of the chains and a repelling pressure is set up in a direction transverse to the direction of stretching. The temperature coefficient of the tension agrees with the kinetic explanation. (Copied complete *J. T. I.*, Sept., 1932.) (S)

HYDROGEN ION CONCENTRATIONS ON WOOL AT VARIOUS TEMPERATURES: THE INFLUENCE OF. A. W. Davison. *The Hunter Counselor,* Oct., 1932, P. 11.

Continuing a series of articles on physical chemistry of wool. The present article reviews largely work by Barmore, a part of whose work was published in the *American Dyestuff Reporter* during 1931. The following conclusions are noted: Distilled water (or neutral tap water) does not affect the tensile strength of wool (when re-dried), regardless of temperature or reasonable time of contact. For baths of the same temperature, loss in tensile strength is practically zero for values of pH up to 7. As pH increases above 7, loss in tensile strength increases. For given values of pH, loss in tensile strength doubles for every rise of approximately 15° F. For given temperatures and values of pH, loss in tensile strength initially increases rapidly, then slows up, with time of contact. Discoloration is negligible (at least to the eye) for pH values up to about 9.5. Above this value discoloration increases rapidly, especially for long time periods. (S)

WOODY PLANT MEMBRANES: DETECTION OF, WITH PHLORO GLUCINOL AND HYDROCHLORIC ACID. W. Plahl. (*Z. Untersuch. Lebensm.,* 1931, 62, 603–606.)

As the result of a number of experiments carried out under different conditions, the following procedure is recommended: The specimen is freed from fat in the usual way and extracted in warm water, or in 50 to 60 per cent. alcohol, to dissolve cell-juices; starch need not be removed. The section is then treated with 2 drops of a reagent consisting of equal volumes of a 2.5 per cent. solution of phloroglucinol in 96 per cent. alcohol and an aqueous solution of chloral hydrate (5: 2), to which mixture 4 per cent. of hydrochloric acid (sp. gr. 1.124 to 1.126) is added. The test is best carried out in a watchglass, any excess of reagent being removed by a strip of filter-paper before the specimen is transferred to the microscope slide. The color is visible after 5 minutes; it reaches its maximum after 15 minutes, and is stable for a day. (Copied complete *The Analyst,* Feb., 1932.) (S)

II. YARNS AND FABRICS

COTTON YARNS DYED WITH SULFUR BLACKS: TENDERING OF. II. THE DEVELOPMENT OF SULFURIC ACID. Tozo Kubota. *J. Soc. Chem. Ind. (Japan),* 35 Suppl. Binding, 1932, 203–4.

Dyed yarns heated for 50, 100, 150 and 250 hours at 100° C. in air, and fresh yarns, were extracted with ether and water, and mechanically adhering sulfur, free sulfuric acid and total sulfate were determined. The development of H_2SO_4 is due to oxidation of the dyestuff itself, not adhering sulfur. Permanency on storing is secured if free acid is under 0.01 per cent. and sulfate under 0.1 per cent.

III. After Treatment to Prevent Tendering of Sulfide Black Dyeings. Ibid., 204–5.

Treatments with soap remove the excess acid and secure permanency. No evidence was obtained either of prevention of oxidation by the soap film or of catalytic hastening of oxidation by the soap alkalies. (Copied complete from *Chem. Abs.*, 1932, 26, 4476.) (W)

Dyed Fabrics: Fastness to Vulcanization. A. V. Surovaya. *Izvestiya Tekstil. Prom. Torgov.*, 1931, Vol. 10, No. 6, P. 29–31; *Chim. et Ind.*, 1932, 27, 1405.

Tests on 80 dyes of various groups (direct, basic, indanthrene, sulfur, acid, and chrome) were carried out by vulcanizing, for 3 hours at 132–4° and 2.5 atmospheres, fabrics coated with a layer of rubber of the following composition: Rubber 100, lead oxide 14, sulfur 3.5, resin 7, chalk 120, accelerator 0.4. Tests were also carried out by cold vulcanizing with SCl_2. A slight fading of the shade was produced by hot vulcanization with all classes of dyes except acid dyes, and those formed on the fibre which showed somewhat better fastness. Cold vulcanization gave much more irregular results with the different groups of dyes. The vulcanizing mixtures themselves and the presence of vapors of benzine, kerosene, and spirit of turpentine in the vulcanizing oven have no effect on the change in color. SCl_2 in cold vulcanizing weakens the fabrics. The rubber coating does not increase the fastness of the fabrics to light. The results of these laboratory tests confirm those of commercial tests. (Copied complete from *Chem. Abs.*, 1932, 26, 4476.) (W)

Pathogenic Fungus on Wool Cloth. A. G. Gould and E. K. Carter. *Am. J. Hyg.*, 1931, 14, 694.

An old woollen jersey, saturated with stale human perspiration, was cut into a number of one-inch squares, and upon each was placed a particle of a fresh culture of *Tricophyton interdigitale*, care being taken that none of the medium itself was transferred. A particle was also placed in a sterile Petri dish. The squares of cloth and the Petri dishes were incubated, sterile water being added daily to all. At intervals over two months, inoculations were made on nutrient media from the growth itself, and also from the piece of cloth from which the growth had been removed, so far as was possible. From the growth, positive results for *T. interdigitale* only were obtained, and from the cloth almost invariably a non-pathogenic fungus developed without *T. interdigitale*. The authors conclude that, although the pathogenic organism was alive at the end of the period, there was no evidence of development. (Copied complete from *The Analyst*, Jan., 1932.) (S)

Proofed Fabrics: The Tendering of. J. Kirkwood. *Inst. Rubber Ind.*, Trans., 1931, No. 7, P. 228–34.

An experimental investigation of the causes of tendering, in which curing was carried out under various conditions, established the fact that HCl (formed by decomposition of S_2Cl_2 by moisture) is the outstanding cause. Only by eliminating all traces of moisture throughout, including the maintenance of a minimum humidity, can tendering be avoided. Dusting the face of the rubber with an alkaline powder, e.g., MgO + starch, before curing, and treatment with dilute ammonia after curing, are both

of great benefit in minimizing tendering. Sulfur dyes or traces of bleaching agents in fabrics are also independent causes of tendering. (Copied complete from *Chem. Abs.*, 1932, 26, 3958.) (W)

III. Chemical and Other Processing (Not Otherwise Classified)

Copper in Fabrics and Rubberized Materials: Simplification and Improvement in the. F. Kirchhof. *Chem'ztg.*, 1932, 56, 296–7; cf. *Chem. Abs.*, 26, 2083, 3958.

The determination of small quantities of copper in fabrics and rubberized materials by ignition, oxidation with $HNO_3 + H_2SO_4$ or $HCl + KClO_3$, separation as CuS, and final titration by the NH_3–Cu method, can be simplified by heating and evaporating to dryness with conc'd. HNO_3 which accelerates the subsequent ignition to ash. This also avoids the frequent danger, when Cl is present, of loss by volatilization as $CuCl_2$. Precipitation of CuS can be avoided by repeating the pptn. of the dissolved ash (containing predominantly Fe and Al) with NH_4OH. This second precipitate contains only 1–2 per cent. of the total copper, and can be discarded. The iodometric reaction for determining copper is recommended instead of the NH_3–Cu colorimetric method, and by using starch the sensitivity is increased 100 fold. It is applicable only if Fe and nitrates are absent, and therefore the iron-free solution is evaporated with H_2SO_4 and redissolved. By this method only 0.1 as much original sample is required. (W)

Dyeing and Printing: Chemical-Technical Investigation of. Kurt Bross. *Leipzig. Monats. Tex. Ind.*, 1926, 41, 316–20; 1927, 42, 354–6, 523; *Chem. Zent'blatt.*, 1931, II, 315.

II. The So-Called Antoxidation of Sulfur Black Dye.

The formation of H_2SO_4 on cotton yarn dyed with sulfur black was investigated. After dyeing the material should always be chromed and then washed a long time with a large amount of boiling water instead of soap. This completely removes the oxidized sulfur. The acid formed on the dyed cotton increases during storage. (Copied complete from *Chem. Abs.*, 1932, 26, 4475.)

III. Comparative Tests for Fastness to Perspiration.

IV. Comparative Investigations of Strength of Dyes. (W)

Energy Transformations at Surfaces. II. Photoluminescence of Fluorescent Dyes at Surfaces. A Hirsch, H. Kautsky, W. Baumeister. *Ber. Deut. Chem. Ges.*, 64: 2053–9, No. 8, 1931.

The fluorescence of the adsorbates was studied while they were in sealed tubes. The dyes were absorbed upon silica-gel E or aluminium hydroxide gel, washed in water and then dried. The fluorescence in daylight of these adsorbates was similar to that of the dye solutions. The colors of the phosphorescence and fluorescence of corresponding adsorbates are similar. Phosphorescence brightness and duration are dependent on the concentration of the dye and very strongly so on the temperature. Duration is decreased

while intensity is increased with rise in temperature. (Copied complete *Eastman Kodak Bull.*, June, 1932.) (S)

SCOURING ACTION OF SOAP ON SILK. R. Tsunokaye. *J. Soc. Chem. Ind.*, (Japan), 35 Suppl. Binding, 1932, 147–53.

The scouring action of soap on silk consists first in a degumming action on the raw silk, and, second, in the effect of the soap on the scoured silk. The degumming action of soap is due to the alkali developed by hydrolysis and accompanied by so-called acid soap, termed by T. colloidal fatty acid soap made of fatty acid derived from the hydrolysis combined with the undecomposed soap. The alkali in the soap solution combines with sericin and fibroin. The scouring action of the colloidal fatty acid soap is due to its strong adsorptive and penetrating powers. (Copied complete from *Chem. Abs.*, 1932, 26, 3929.) (W)

IV. RESEARCH METHODS AND APPARATUS

DESIZING OF FABRICS: METHODS OF STUDYING THE. P. M. Pogoyev and E. A. Raklin. *Izvestiya Tekstil. Prom. Torgov.*, 1931, 10, Nos. 3–4, P. 80–1; *Chim. et Ind.*, 27, 909.

The usual method of determining the degree of sizing consists in determining the loss in weight of the fabric. This method is inaccurate because the desizing treatment removes not only sizing materials, but also a certain amount of impurities and part of the degraded fibres. It is preferable to determine starch before and after desizing and the following method is recommended: Immerse 2 g. of fabric for 5 minutes in hot water, cool to 60°, add 20 cc. of 10 per cent. biolase solution, let stand until no starch reaction is obtained on testing with iodine, remove the fabric and wash with hot water. To the combined solution and washings add 10 cc. of conc'd HCl, heat on boiling water bath for 3 hours under reflux condenser, cool, neutralize to litmus with NaOH, make to 500 cc. To a 50 cc. aliquot, add 20 cc. of 0.02 N iodine and 50 cc. of a 1:1 mixture of Na_2CO_3 (42.4 g. per liter) and $NaHCO_3$ (33.6 g. per liter). Let stand in the dark for 1.5–2 hours, acidify with 12.5 cc. of 25 per cent. H_2SO_4, and titrate excess iodine with 0.01 N $Na_2S_2O_3$. One cc. of 0.01 N iodine = 0.0088 g. glucose = 0.0084 g. starch. (Copied complete from *Chem. Abs.*, 1932, 26, 3930.) (W)

DETERMINATION OF METHOXYL, LIGNIN AND CELLULOSE IN PLANT MATERIALS. M. Phillips. (*J. Assoc. Official Agric. Chem.*, 1932, 15, 118–131.)

Brief summaries are given of the literature dealing with these determinations. For methoxyl, the modification of the Zeisel and Fanto apparatus (*Z. anal. Chem.*, 1903, 42, 554) recommended is described, and the procedure followed is given in detail.

For lignin, the method used is that depending on dissolving the cellulose and other carbohydrates by means of fuming hydrochloric acid and weighing the residual lignin. An apparatus is described in which two separate 1-grm. samples of the material, previously extracted with a mixture of 32 parts of 95 per cent. alcohol and 68 parts of benzene, and

dried, are treated side by side with the acid. After the two residues of crude lignin have been dried and weighed, one of them is incinerated and the ash weighed; in the other the nitrogen-content is determined by the Kjeldahl method. Then, lignin = crude lignin — ash — (nitrogen x 6.25).

For determining the cellulose, use is made of the chlorine-treatment method. Two 1-grm. samples of the extracted and dried material are weighed in fritted glass crucibles, the weighings being made in weighing bottles. One of the crucibles is then fitted to a filter flask, and washed through with water, chlorine (water-scrubbed) being then passed through the crucible for 5 minutes, at the rate of one bubble per second. The material is next washed with dilute sulphurous acid, followed by water. The crucible is then placed in a 250-c.c. beaker filled with 2 per cent. sodium sulphite solution to within one-half inch of the top of the crucible, and the beaker is left on a steam-bath for 30 minutes. The second crucible is treated similarly, each being then washed with water under suction, and again chlorinated and digested with sodium sulphite solution. This procedure is repeated until the chlorinated material no longer gives the reddish-violet reaction of lignin chloride with sodium sulphite solution.

Finally, the cellulose in the crucibles is bleached by adding 20 c.c. of 0.1 per cent. potassium permanganate solution, leaving at room temperature for 10 minutes, and rendering colourless with dilute sulphurous acid. It is then washed, successively, with very dilute ammonia solution, hot water, 95 per cent. alcohol, and ether, dried at 105° C., and weighed. On a weighed portion of the final product the ash is determined. The ash-free cellulose, thus determined, is reported as 'Cross and Bevan cellulose.' In some cases the pentosans in this cellulose are determined by the furfural method, cellulose less pentosans being returned as 'pure cellulose.' The assumption that all the furfural is derived from pentosans is not, however, justified. (Copied complete from *The Analyst*, May, 1932.) (S)

DETERMINATION OF RELATIVE HUMIDITIES BY MEANS OF THERMOCOUPLES. J. H. Lanning. *J. Ind. & Eng. Chem., Anal. Ed.*, July 15, 1932, P. 286.

Where small volumes of air are maintained at constant humidity by means of chemical reagents, as in a desiccator, use of the ordinary wet and dry bulb thermometer for the determination of relative humidity existing at any instance is not possible. The author describes in some detail the construction and operation of electric thermocouples which will exhibit definite potential difference when one is immersed in a small drop of water. A suitable potentiometer in combination with a sensitive galvanometer serves to furnish data in millivolts which can be calibrated against temperature in degrees Fahrenheit. The resulting plot is stated to be a substantially straight line, and example is given. A table is also included showing the potential difference, the relative humidity, and the wet and dry bulb differences. Provision is made for supplying the necessary water automatically and the whole assembly is presented in a diagrammatic sketch. (S)

FERRICYANOGEN NUMBER: DETERMINATION OF THE. Freiberger. *Leipzig. Monats. Tex. Ind.*, 1930, 45, 440–2; *Chem. Zent'Blatt.*, 1931, I, 1855.

The ferricyanogen number is a measure of the reducing ability of the substance investigated. It is the amount of solid $K_3Fe(CN)_6$ necessary to react with 100 g. of cellulose, etc. It is determined as follows: 0.1–0.2 g. of the material is placed in a test tube with some glass beads, 10 cc.

of 0.01 N $K_3Fe(CN)_6$ and 10 cc. of 10 per cent. NaOH are added. After heating for 10 minutes at 100° and cooling, 2 cc. of acetic acid are added, then K I, starch solution, 10 cc. of zinc solution (50 g. in $SO_4.7H_2O$ and 250 g. NaOH per liter). The blue solution is titrated with $Na_2S_2O_3$, and a blank is run without cellulose. Difference between the two titrations × the thiosulfate titer = $K_3Fe(CN)_6$ that reacted with the material under test. From the oxygen consumption, the oxygen number can also be calculated. A series of the numbers for textiles, oils, starch and protein are given. (Copied complete from *Chem. Abs.*, 1932, 26, 4273.) (W)

Fluorescence Microscopy with Strong Illumination. M. Haitinger. (*Mikrochemie*, 1931, 9, 430–440.)

Faintly fluorescing substances, such as the chlorophyll in algae, are not sufficiently illuminated by mercury lamps or carbon arc lamps for microscopy. Brighter illumination is given by an arc lamp with iron as the electrode metal. Iron is the most suitable element, as it emits light a large percentage of which has wave-lengths between 3000 and 4000 Å. U. To maintain evenness of illumination and to prevent poisoning of the electrodes by formation of iron oxide, the electrodes are as short as possible, and imbedded in coolers of ribbed brass; they are also bored and filled with brass. With direct current of 5 amperes the arc glows with sufficient regularity for hours. The light from the arc passes through a convergent lens of quartz or glass non-absorbent of ultra-violet light, then through a dark glass ultra-violet light-filter and a solution of copper sulphate, to absorb red rays, before being directed on to the mirror of the microscope. The loss of ultra-violet light on a silvered glass mirror, when the glass does not absorb ultra-violet light, is negligible. However, iron plated with chromium may also be used as a mirror. The light passes through a dark ground condenser of quartz, or glass which does not absorb ultra-violet light, on to the object. To prevent any ultra-violet light coming through to the eyes or photographic plate a stopping filter must be used; this cuts off the light between 3000 and 4000 Å. U. As the illumination is very bright, short exposures of a few minutes are sufficient for photographing the fluorescence. The apparatus is suitable for work at any magnification; for high powers the microscope is used horizontally and the mirror dispensed with, to avoid the slight loss of light. The dark-glass filter can be rapidly replaced by an opal glass filter for comparison with the appearance of the object in ordinary light. When non-transparent objects are viewed, incident light must be used; this is achieved by means of a periscope of two mirrors. (Copied complete *The Analyst*, Feb., 1932). (S)

Simple Fluorescence Microscopy and Fluorescence Photomicrography. P. Metzner. (*Mikrochemie*, 1931, 9, 72–91.)

A parabolic mirror (Busch) is described, made of a metal which strongly reflects ultra-violet light, for attachment to the microscope in observing fluorescence phenomena in incident light. The mirror focuses the ultra-violet light on to the object to be observed, and renders sufficient the illumination obtained from an ordinary quartz or mercury lamp. The illumination can be still further increased by interposing a round glass flask filled with distilled water, as a focusing lens, between the lamp and the black ultra-violet light-filter, and so adjusted that the image of the

lamp falls on the mirror. This is better than a large lens, which would absorb some ultra-violet light. When an arc lamp is used, nickel is preferable to carbon, as it emits more ultra-violet light. The condenser lens of the arc lamp, which may be of ordinary glass (though Uviol glass is better) is adjusted to give almost parallel light which falls horizontally on the parabolic mirror. An ultra-violet light-filter is placed between the lamp and the microscope, and, to absorb red rays the beam is passed through a half-saturated solution of copper sulphate in a container made of two thin-walled glass plates held together by a thick rubber ring, in which are two holes for filling. The illumination by means of the parabolic mirror is suitable for use with low-power objectives (up to Leitz 5). For photographic purposes it is necessary to use a 'Euphos' cover-glass (Zeiss), or an ultra-violet light-filter to cut out any ultra-violet light that may be reflected. A number of photographs were taken of plant material in a non-fluorescing medium (water or glycerin). The time of exposure varied from 20 to 60 minutes. (Copied complete *The Analyst*, Feb., 1932.) (S)

SULFUR DYE BATHS: ANALYSIS OF. E. P. Celivanov. *Izvestiya Tekstil. Prom. Torgov.*, 1931, 10, No. 5, 41–3; *Chim. et Ind.*, 1932, 27, 910.

The following method is recommended: (1) Add sufficient NaOH for complete precipitation of the dye and solution of the liberated sulfur. (2) To another portion add $MgSO_4$ solution to precipitate MgO, $MgCO_3$ and the dye. (3) To another portion add MSO_4, which precipitates the dye, along with $Zm(OH)_2$ and the sulfides. (2) and (3) are filtered on Gooch crucibles and the filtrates titrated iodametrically to obtain sulfides. Another portion of the original bath and the filtrate of (2) are oxidized with CrO_3, the difference corresponding to the amount of CrO_3 required to oxidize the dye. The analysis is completed by determination of the total alkalinity, Baumé reading. The method is much simpler than those heretofore suggested and permits of easily controlling the composition of the bath before and during dyeing. (Copied complete from *Chem. Abs.*, 1932, 26, 3925.) (W)

WASHING, ESPECIALLY WITH PHOSPHATE CONTAINING WASHING AGENTS ON COTTONS: AN INVESTIGATION OF THE INFLUENCE OF. P. E. Raschow, V. A. Larsen, O. F. Saabye, K. Hansen, H. Schultz and P. Mortensen. *Denmark's Naturvidenskabelige Samfund.*, Ser. A, 1927, No. 13, 3–28; *Chem. Zent.'Blatt.*, 1931, II, 1650; *Chem. Abs.*, 1932, 26, 4478.

Conclusions: Sometimes comparatively harmless, or under certain conditions, injurious action of perborate is to be accounted for by the difference in the velocity of its decomposition on the fabric. The larger the amount of substances present which accelerate the decomposition, as certain dyes, dirt and metallic catalysts, and the more concentrated the perborate, the greater is the danger of weakening the fabric. The weakening effect is lessened by conditions which hinder perborate decomposition, such as hardness in the water. In washing with hard water perborate can probably be used without any great risk if the washing agent contains some water glass in addition to soap and soda, and at the most 3 per cent perborate, and if the washed cotton is afterwards dried. (W)

V. Economic Research and Miscellany

Lignin Made Artificially by Heating Cellulose. *Science News Letter.* November 12, 1932, P. 309.

Lignin, one of the chief constituents of wood, and as yet one of the most puzzling to chemists and industrialists, has been made artificially in the U. S. Forest Products Laboratory at Madison, Wis., by Drs. L. F. Hawley and E. E. Harris. This research followed pioneer work done previously by Dr. Hawley with Dr. Jan Wiertelak.

Lignin was made in sealed tubes, by heating cellulose, the most useful constituent of wood, at a temperature of 135 degrees C. for periods up to eight days in length. The artificial lignin thus obtained gave the same reactions as the natural lignin to various chemical tests.

It is not expected that this artificial lignin will be of immediate direct commercial importance. On the contrary, natural lignin is now a nuisance and expense to chemical manufacturers, for they do not know any use for it, and in making wood pulp have to get rid of it by various costly methods. But the discovery of Drs. Hawley and Harris will eventually be of economic value, because it leads to a better knowledge of what lignin is and will do, and this knowledge in turn is of use either in getting rid of it or even in finding a profitable occupation for it. (Copied complete.) (S)

Publications Abstracted

A Key to Abbreviations of Publications Used in Abstracts and Bibliography

(*Continued from November Issue*)

Am. J. Hyg. ..... *American Journal of Hygiene*
Am. J. Roent. ..... *American Journal of Roentgenology and Radium Therapy*
Brit. J. Phot. ..... *British Journal of Photography*
Brit. Plastics ..... *British Plastics and Moulded Products Trader*
Bull. Sericul. & Silk Ind. ..... *Bulletin of Sericulture and Silk Industry*
Inst. Rubber Ind., Trans. ..... *Institution of the Rubber Industry, Transactions*
Izvestiya Tekstil. Prom. Torgov... *Izvestiya Tekstilnoi Promuishlennosti i Torgovli*
J. Am. Leather Chem. Assoc. .... *Journal of the American Leather Chemists' Association*
J. Assoc. Official Agric. Chem. .. *Journal of the Association of Official Agricultural Chemists*
J. Chem. Education ..... *Journal of Chemical Education*
J. Hered. ..... *Journal of Heredity*
J. Home Econ. .. .. *Journal of Home Economics*
J. Sci. Instr. ..... *Journal of Scientific Instruments*
Kinemat. Weekly ..... *Kinematics Weekly*
Photo J. ..... *Photographic Journal*
Tech. Review ..... *Technology Review*
Trans. A. S. M. E. ..... *Transactions of the American Society of Mechanical Engineers*
Z. Untersuch. Lebensm. ..... *Zeitschrift für Untersuchung der Lebensmittel*

Bibliography

I. Fibres (Synthetic and Natural) and Fibre Analysis

Acetate Silk Manufacture. *Ind. Chim.*, 7: 464–9, November, 1931.

A brief illustrated survey is given of the manufacture of acetate silk at the works of Alliance Artificial Silk, Ltd. (Copied complete *Eastman Kodak Bull.*, June, 1932.) (S)

Cellulose Acetate: Fractions of Commercial. R. O. Herzog and A. Deripasko. *Cell'chem.*, 13: 25–31, Jan. 10, 1932.

Fractionation experiments (using acetonewater mixtures) were carried out on commercial cellulose acetate and the properties of the various fractions were determined. Stress-strain curves of film from different fractions are shown. (Copied complete *Eastman Kodak Bull.*, June, 1932.) (S)

Cellulose in Industry. Hervey J. Skinner. *J. Ind. & Eng. Chem.*, June, 1932, P. 694.

Paper read at the 83d meeting of the American Chemical Society, New Orleans, Spring of 1932. A summarized account of the sources of cellulose from the commonly used fibres and woods together with other potential sources as from straw, cornstalks and bagasse. The author continues with a description of cellulose derivatives including nitro-cellulose, cellophane, and cellulose acetate; and concludes with a very brief reference to the present status of cellulose research. (S)

Cotton Plants, Tame and Wild. Thos. H. Kearney. *J. Hered.*, May, 1930, P. 195–210.

The article discusses the beginnings of European contact with cotton; what cotton plants are like; development and structure of the seed hairs; biological significance of the seed hairs; geographical distribution of gossypium; classification of the cultivated forms; wild species of gossypium; origin of the modern commercial cottons. (S)

Waterproofing Rayon. P. Dutreillis. *Russa*, 1932, 7, 301.

A brief outline of various processes. (Copied complete from *Chem. Abs.*, 1932, 26, 4478.) (W)

II. Yarns and Fabrics

Roll Spacing Determinator. *Cotton*, November, 1932, P. 71.

A new machine, known as the 'Distanceur,' for determining the correct roller settings, drafts and weights, from drawing frames to spinning frames is described. It is explained that with this machine, roller settings, drafts, and weights may be changed by means of levers and cranks while the machine is running, without stopping the machine and without any calculations. Through a new tension lever, in connection with a viewing device, the correct roller spacing is found and read directly from a scale.

The function of the machine is to provide a means for determining the effect of different roller settings, drafts, etc., without the necessity of changing these settings on a standard frame. (Copied complete.) (S)

III. Chemical and Other Processing (Not Otherwise Classified)

Dyes Derived from Triphenylmethane. The Constitution of the Green Dye Obtained from Dibenzaldihydrazimotriphenyl Methane. A. Giacalone and G. Scarpinati. *Bazz. Chim. Ital.*, 1932, 62, 189–201.

(Copied complete from *Chem. Abs.*, 1932, 26, 4324.) (W)

IV. Research Methods and Apparatus

A Controlled-Humidity Room for Testing Textiles. M. B. Hays. *J. Home Econ.*, 1931, 23, 662–8.

(Copied complete from *Chem. Abs.*, 1932, 26, 4477.) (W)

Humidity Control in Silk-Mill Operations. Benjamin Levitt. *Silk*, 1932, 25, No. 4, P. 18–20.

(Copied complete from *Chem. Abs.*, 1932, 26, 4477.) (W)

Microscopic Detection of Thallium in Fabrics. V. Barbaglia. *Studi. Sassaresi*, 1930, Sept., 4 pp.; *Chem. Zent'Blatt*, 1931, I, 3265–6.

The preparation is soaked in saturated alcoholic 95 per cent. potassium iodide solution, in which the thallium separates as iodide. (Copied complete from *Chem. Abs.*, 1932, 26, 4477.) (W)

Microcinematography: Evolution of. J. Comandon. *Intern. Rev. Educational Cinemat.*, 4: 413–20, June, 1932.

A short and general review is given including a photograph of the author's apparatus. (Copied complete from *Eastman Kodak Abstract Bull.*, Sept., 1932.) (S)

Short Cuts to Photomicrography. T. T. Baker. *Brit. J. Phot.*, 79: 180–1, March 25, 1932.

A description is given of the types of camera which can be fixed to the microscope. (Copied complete *Eastman Kodak Bull.*, Sept., 1932.) (S)

X-Ray Diffraction Photographs of Vegetable and Animal Fibres. W. T. Astbury. *Photo. J.*, 1932, 72, 318–24.

An elementary discussion well illustrated. (Copied complete from *Chem. Abs.*, 1932, 26, 4263. (W)

Book Reviews

PRACTICAL MICROSCOPY. Martin and Johnson. 116 pages, numerous illustrations; 10 plates. Blackie and Sons, Ltd., London (1931).

An excellent book for the textile microscopist who will find, with the exception of chapters 8 and 9 dealing respectively with metallurgical microscopes and the preparation of specimens, an abundance of well presented information. The simple presentation of the optics of the microscope is to be commended. The book includes an excellent discussion of polarised light as employed in microscopy, of ultra-violet microscopy, and the final chapter on the interpretation of the image, although very short, is excellent. (S)

PRACTICAL SCIENCE FOR THE DRYCLEANING INDUSTRY. By Warren K. Cooley. Published by the National Association Institute of Dyeing and Cleaning, Inc. 211 pages, 21 illustrations (1930).

In the 12 chapters the various materials and techniques used in the dry-cleaning industry are outlined in very elementary language. It is intended for the student with least preparation and for the plant owner without previous knowledge of high school or college chemistry. While most of the illustrations are pertinent the charts could be considerably improved and a full page half-tone illustrating the use of the microscope is obviously posed for the purpose since the user of the microscope could see nothing at all of the specimen with the instrument as set. It would have been just as easy to illustrate the actual use of the instrument. (S)

"Industry gets many fundamental scientific discoveries out of which inventions are carved and industries are founded from results of the independent work of men of science in university laboratories."—D. C. Jackson.